

Regulatory and Permitting Issues

Topical Report

*West Coast Regional Carbon Sequestration Partnership
(WESTCARB)*

Contract Period: October 1, 2003–September 30, 2005

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September 30, 2005

DOE Contract No.: DE-FC26-03NT41984

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Abstract

As part of the West Coast Regional Carbon Sequestration Partnership (WESTCARB), Terralog Technologies USA, Inc., reviewed current state and federal regulations related to carbon dioxide capture and storage within geologic formations and enhanced carbon uptake in terrestrial ecosystems. We have evaluated and summarized the current and possible future permitting requirements for the six states that comprise the West Coast Regional Partnership. Four options exist for CO₂ injection into appropriate geologic formations, including storage in: (1) oil and gas reservoirs, (2) saline formations, (3) unmineable coal beds, and (4) salt caverns. Terrestrial CO₂ sequestration involves improved carbon conservation management (*e.g.* reduction of deforestation), carbon substitution (*e.g.*, substitution for fossil fuel-based products, energy conservation through urban forestry, biomass for energy generation), and improved carbon storage management (*e.g.*, expanding the storage of carbon in forest ecosystems). The primary terrestrial options for the West Coast Region include: (1) reforestation of under-producing lands (including streamside forest restoration), (2) improved forest management, (3) forest protection and conservation, and (4) fuel treatments for the reduction of risk of uncharacteristically severe fires (potentially with associated biomass energy generation). The permits and/or contracts required for any land-use changes/disturbances and biomass energy generation that may occur as part of WESTCARB's activities have been summarized for each state.

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1 Executive Summary

In 1997, the U.S. Department of Energy (DOE) started the Carbon Sequestration Program. Carbon dioxide (CO₂) is a potent greenhouse gas. Carbon dioxide capture and storage within geologic formations and enhanced carbon uptake in terrestrial ecosystems are the two main sequestration options. Seven Regional Carbon Sequestration Partnerships were formed; Terralog Technologies belongs to the West Coast Regional Carbon Sequestration Partnership (WESTCARB) and is responsible for reporting on the regulatory and permitting issues for CO₂ sequestration.

Carbon dioxide generated from industrial activities can be sequestered through capturing, transporting, and injecting it into appropriate geologic formations, or through uptake by terrestrial ecosystems. For injection into appropriate geologic formations, options include storage in:

- Oil and gas reservoirs,
- Saline formations,
- Unmineable coal beds, and
- Salt caverns.

Injection of CO₂ into geologic formations requires an Underground Injection Control (UIC) permit from the U.S. Environmental Protection Agency (EPA). EPA has delegated primary regulatory authority to state agencies that have demonstrated an ability to implement UIC programs that meet EPA requirements. These states are referred to as “primacy states”. In states that have not received primacy status, the responsible permitting agency is EPA. Currently, EPA does not differentiate between CO₂ storage and CO₂ disposal in any geologic formation, but is endeavoring to ensure a universal standard and perhaps classification to which all agencies will adhere. The permit requirements for each of the above options have been documented and their respective regulations cited. We suggest that EPA should promulgate the ruling with input from the states and standardize the different regulations that exist for different states.

Terrestrial CO₂ sequestration involves improved carbon conservation management (*e.g.* reduction of deforestation), carbon substitution (*e.g.*, substitution for fossil fuel-based products, energy conservation through urban forestry, biomass for energy generation), and improved carbon storage management (*e.g.*, expanding the storage of carbon in forest ecosystems). Terrestrial options available to the WESTCARB partnership are:

- Reforestation of under-producing lands (including streamside forest restoration),
- Improved forest management,
- Forest protection and conservation, and
- Fuel treatments for the reduction of risk of uncharacteristically severe fires (potentially with associated biomass energy generation).

The required permit/contract for any land use changes/disturbances and biomass energy generation have been summarized for each state. To date, biomass energy generation is not economically feasible without some form of government subsidy or tax credit.

2 Experimental

No experiment was performed for this report. All regulatory reviews and CO₂ sequestration options are described in detail under their respective headings (see Table of Contents).

3 Results and Discussion

3.1 Regulatory Overview

Carbon dioxide (CO₂) generated from industrial activities can be sequestered by capturing, transporting, and injecting it into appropriate geologic formations, or through uptake by terrestrial ecosystems. It is generated by power plants, natural gas operations, refineries, iron and steel industry, petrochemical industries, and hydrogen or methanol production (Herzog *et al.*, 1997). CO₂ is not currently listed as hazardous waste, and it is not regulated under the Clean Water Act (68FR52922-52933).

Injection of CO₂ into appropriate geologic formations requires an Underground Injection Control (UIC) permit from the U.S. Environmental Protection Agency (EPA). The UIC Program was established under the provisions of the Safe Drinking Water Act of 1974 to protect underground sources of useable water. Under this program, five classifications of wells were established:

- Class I – wells used to inject liquid hazardous wastes, industrial non-hazardous liquid, and municipal wastewater beneath the lowermost drinking-water reservoir;
- Class II – wells used to dispose of fluids associated with the production of oil and natural gas, enhanced oil recovery, and storage of liquid hydrocarbon;
- Class III – wells used to inject fluids for the extraction of minerals;
- Class IV – wells used to dispose of hazardous or radioactive wastes into or above drinking water. EPA has banned the use of these Class IV wells; and
- Class V – wells not included in the other classes used to generally inject non-hazardous fluid into or above drinking water.

See “Classification of Wells for Injection of CO₂” (below) for a discussion of permitting of underground CO₂ injection under existing UIC regulations.

EPA has delegated primary regulatory authority to state agencies that have demonstrated an ability to implement UIC programs that meet EPA requirements. These states are referred to as “primacy states”. In many of these states, more than one state agency has primary regulatory authority for one or more classes of injection wells. In states that have not received primacy, the responsible agency is EPA.

3.2 Pipeline Transportation

The most economical means of transporting captured CO₂ is by pipelines. Depending on supply and demand, the transportation of CO₂ may involve temporary storage in either some storage tanks or geological reservoirs before the CO₂ is permanently disposed of within geologic formations.

Pipelines are regulated by U.S. Department of Transportation (DOT), Occupational Safety and Health Administration’s (OSHA’s) confined space regulation, and each State’s Fire Marshall or Public Utility Commission (PUC). In addition, pipelines from wellhead to lease property may be regulated by each State’s equivalent of a Division of Oil and Gas. Table 1 (below) shows the regulations cited by Federal authorities and the responsible state agencies.

Table 1. Federal and state pipeline regulations. (See Appendix I for an explanation of acronyms.)

STATE/ FEDERAL	REGULATING AGENCY	REGULATIONS CITED
Federal	DOT OSHA (confined space) FERC (construction)	49CFR190-199 29CFR1910.146 18 CFR part 1- 399
Alaska	Defer to DOT	49CFR195
Arizona	Arizona Corporate Commission	ACC R14-5-201 to R14-5-205
California	Fire Marshall DOGGR	Gov. Code Sec 51010 to 51019.1, AB592 DOGGR Pipeline regulations
Nevada	Public Service Commission	NAC 704.455 to 704.465
Oregon	PUC	PUC Div.31, 860-031-0001 to 860-031-0041
Washington	UTC	House Bill 2420, Ch191, Laws of 2000, RCW Ch81.11

CO₂ may also be temporary stored in Aboveground Storage Tanks (AST) and transported via pipeline to its final sequestered location at some later time. There is no regulation for CO₂ in aboveground tanks; however, AST is subjected to American Petroleum Institute

standards, Underwriters Laboratories Inc. requirements, and American Water Works Association guidelines.

3.3 Classification of Wells for Injection of CO₂

All six western States belonging to WESTCARB (*i.e.*, Alaska, Arizona, California, Nevada, Oregon, and Washington) define CO₂ as a product when used with enhanced oil recovery (EOR) projects; hence, CO₂ can be injected into a well classified as Class II. For CO₂ injection not related to EOR, the classification of CO₂ as a product or a waste will influence the type of injection well as well as the regulating agency.

The regulations on CO₂ injection wells are currently in flux. It has been suggested by some that CO₂ injection wells should be classified in EPA UIC Class II category (IOGCC, 2005). As of the writing of this report, the authors understand that EPA will probably make no distinction between storage and disposal into any medium such as oil and gas reservoirs, saline formations, coal beds, or salt, nor will EPA distinguish whether the CO₂ is in gaseous or liquid phase. EPA Region X, which includes Alaska, Oregon, and Washington, will probably permit CO₂ injection wells as Class V regardless of whether they are for storage or disposal with permit conditions similar to Class I. However, EPA Region IX will probably permit these well as Class I. EPA needs to ensure that injection wells will have the same standard, regardless of the well classification, and should ensure a universal standard to which all primacy-state agencies will adhere. Ultimately EPA, with input from the States, will have to decide on the proper classification of CO₂.

3.4 Sequestration Options

CO₂ can either be injected into suitable geologic formations or be captured through uptake by terrestrial ecosystems.

3.4.1 Geologic Sequestration Options

Currently, the only permits issued for CO₂ injection within the six States belonging to WESTCARB are for EOR-related injection. The States and the Federal government make no clear distinction between CO₂ storage and CO₂ disposal and, at this time, it appears that EPA will probably treat the storage and disposal of CO₂ by injection in the same category. The responsible agency involved with permitting depends on whether the injection is located on State, Federal or Indian lands and if the state has primacy status with EPA.

For injection on Indian lands, EPA will be the permitting agency. As of the writing of this report, no Indian Nation has primacy status; however, the Navajo Nation is close to obtaining primacy status. For injection on Federal lands, EPA will also be the regulatory agency, and will notify the corresponding state agency and the Bureau of Land Management of the injection. For injection on State lands, the responsible agency will depend on whether or not the state has primacy status with EPA.

The options for geologic sequestration of CO₂, including storage in:

- Oil and gas reservoirs,
- Saline formations,
- Unmineable coal beds, and
- Salt caverns.

Are outlined in the following sections.

3.4.1.1 Oil and Gas Reservoirs

CO₂ injected into oil and gas reservoirs for enhanced oil recovery (EOR) is currently classified as Class II by all 6 western States. CO₂ is classified as a product to enhance the recovery of hydrocarbons in depleted fields. In places where states have primacy, the agencies involved (see Table 2) have control over the Class II well. In states where EPA shares primacy, e.g. Alaska and California; EPA and the state will jointly administer the Class II program. In California, the Division of Oil, Gas, and Geothermal Resources (DOGGR) will issue a Class II well permit. In Alaska, the Oil and Gas Conservation Commission (OGCC) will issue a Class IIR (Enhanced Recovery) well permit for the EOR well. Arizona has no primacy status, so EPA will issue a Class II well permit. However, Arizona OGCC has secondary jurisdiction and an Aquifer Protection Permit is also required from the Department of Environmental Quality (DEQ). A well permitted by EPA may start out as Class II when there is EOR activity, but when EOR activity stops, the well will be reclassified as either Class I or V depending on which EPA jurisdiction it falls within.

Table 2. Federal and state EOR permit requirements. (See Appendix I for an explanation of acronyms.)

STATE	REGULATING AGENCY	WELL/PERMIT TYPE	REGULATIONS CITED
Alaska	EPA OGCC share primacy w/EPA	Class IIR	40CFR144-148 20AAC25; 31 AK O&G Consvr. Act Ch31.05
Arizona	EPA no primacy w/state OGCC DEQ	Class II 2 nd jurisdiction Aquifer Protection Permit	40CFR144-148 12AAC7; ARS 27-516 ARS 49-241; 18AAC,Ch9
California	EPA DOGGR share primacy w/EPA	Class II	40CFR144-148 14CCR Div2, Ch2, 4; Public Resources Code 30262
Nevada	DEP DOM BLM	Class II (Interagency Cooperation between 3 agencies)	NAC445A.810 to 445A.925 NAC Ch522; NRS 445A.470 43CFR Ch2 Part3160
Oregon	DEQ DOGAMI	Class II Interagency cooperation	40CFR144-148; 44OAR340-044-0005 and Appendix A OAR Ch.632 Div. 10; ORS 520
Washington	Dept. of Ecology DNR	Class II (joint control)	40CFR144-148; WAC173- 218 78.52 RCW

Currently, all CO₂ injection into oil and gas reservoirs is associated with EOR. The permitting situation for injection into depleted oil and gas reservoirs that will not be related to EOR or enhanced gas recovery (EGR) will likely be similar to that for saline formation. See the section on Saline Formations (below) for a discussion of how agencies might permit this type of injection.

3.4.1.2 Saline Formations

Regulations of CO₂ injection in saline formations are not yet well defined and are not consistent between states. For example, Nevada, Oregon, and Washington prohibit Class I wells. In Oregon and Washington, EPA Region X will probably classify CO₂ injection wells as Class V; however, Oregon only allows shallow Class V wells—less than 30 m (100 ft.) deep—because of subsurface conditions. In EPA Region IX, which includes

Arizona, California, and Nevada, CO₂ injection wells will most probably be classified as Class I; however, similar to Oregon, Nevada prohibits Class I wells because of subsurface conditions. It should be noted that the different classifications of CO₂ wells is of lesser importance when compared to operational requirements (based on criteria, standards, geology, for example) for each CO₂ injection application.

In Alaska, the OGCC permits disposal (including CO₂) as Class IID wells. This classification depends on the fluid stream and a compatibility demonstration; for example, kitchen and compound wastes can be disposed of using Class IID well if the disposal is used for flooding purposes. Table 3 (below) summarizes permit conditions and regulations for CO₂ injection not related to EOR.

Table 3. Federal and state potential permit requirements for CO₂ injection NOT related to EOR. (See Appendix I for an explanation of acronyms.)

STATE	REGULATING AGENCY	WELL/PERMIT TYPE (If not EOR related)	REGULATIONS CITED
Alaska	EPA OGCC share Class II primacy w/EPA	Class V	40CFR144-148 20AAC25; 31 AK O&G Consvr. Act Ch31.05
Arizona	EPA no primacy w/state OGCC	Class I	40CFR144-148 12AAC7; ARS 27-516
California	EPA DOGGR share Class II primacy w/EPA	Class I	40CFR144-148 14CCR Div2, Ch2, 4; Public Resources Code 30262
Nevada	DEP DOM BLM joint interagency cooperation	Unknown, Class I prohibited	NAC445A.810 to 445A.925 NAC Ch522; NRS 445A.470 43CFR Ch2 Part3160
Oregon	DEQ DOGAMI	Class V, <30 m (100 ft.) well only Interagency cooperation	44 OAR 340-044-0005 and Appendix A OAR Ch.632 Div. 10; ORS 520
Washington	Dept. of Ecology	Class V	40CFR144-148; WAC173-218

3.4.1.3 Methane-Bearing Coal Beds

Regulations for CO₂ injection into coal beds for enhanced coal-bed methane (ECBM) recovery vary among the three WESTCARB states (Alaska, Arizona, and Washington) that have sizable deposits (Hart's E&Pnet, see Figure 1). Washington (primacy status) has permitted one Class II injection well for ECBM. Since ECBM deals with hydrocarbon recovery, it appears that CO₂ injection for ECBM would lead to a Class II classification. CO₂ injection for ECBM can be thought of as a form of EGR. Alaska OGCC will jointly administer Class II well with EPA (share primacy) for EGR injection. Because Arizona has no primacy status, EPA will administer the Class II well program for EGR in this state. For non-EGR-related injection in states without primacy, EPA Region X most probably will permit the CO₂ injection regardless if it is for storage or disposal as Class V well with permit conditions similar to Class I. EPA Region IX will most probably permit ECBM-related wells as Class I.

Storage of CO₂ in ECBM produces a significant amount of water during the initial injection phase, and the disposal of the water produced may require a National Pollutant Discharge and Elimination System (NPDES) permit (Veil, 2002).

Table 4. Federal and state potential coal-bed methane permit requirements. (See Appendix I for an explanation of acronyms.)

STATE	REGULATING AGENCY	WELL/PERMIT TYPE	REGULATIONS CITED
Alaska	EPA	Class V non EGR related	40CFR144-148; CWA 40CFR 122, 40CFR147.52
	OGCC share primacy w/EPA	Class II for EGR	20AAC25; 31 AK O&G Consvr. Act Ch31.05
Arizona	EPA no primacy w/state DEQ	Class II for EGR Class I non EGR related Aquifer Protection Permit	40CFR144-148; CWA 40CFR 122; 40CFR147.52 ARS 49-241; 18AAC Ch9
Washington	Dept. of Ecology	Class II	40CFR144-148; CWA 40CFR 122, 40CFR147.52;
	DNR	Waste Water Permit Class II (joint control with Dept. of Ecology)	WAC173-218 WAC173-226 78.52 RCW

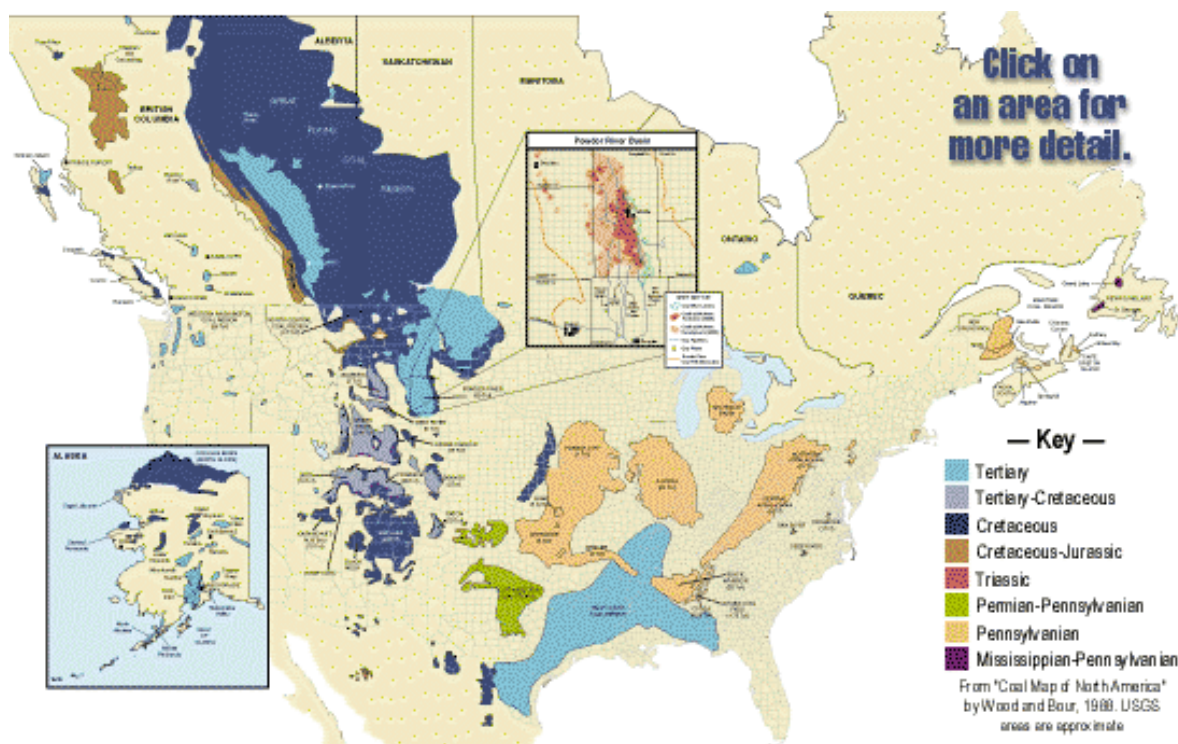


Figure 1. North America coal-bed methane resource map

Source: Hart's E&P Magazine

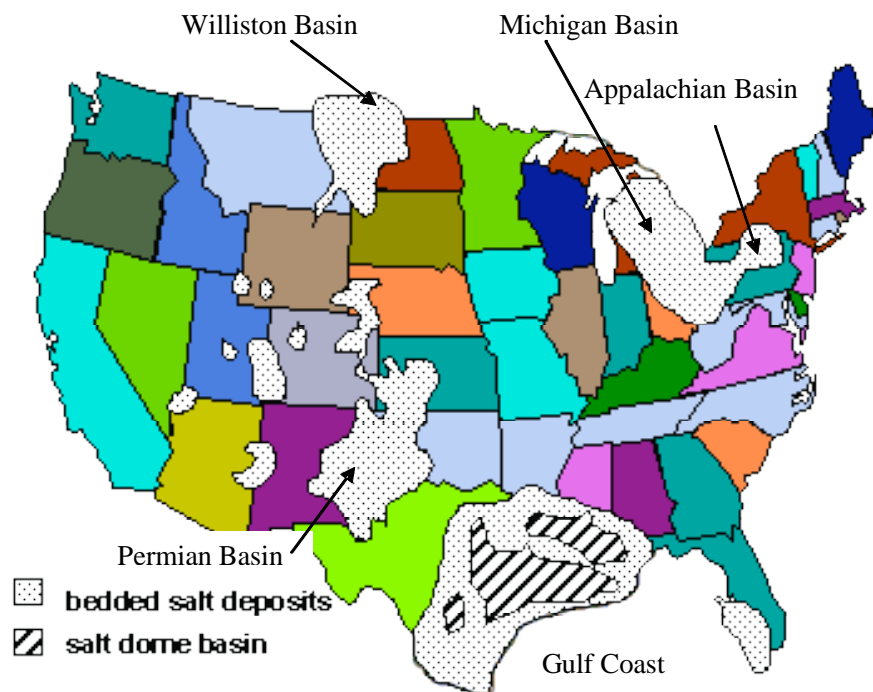
3.4.1.4 Salt Caverns

Arizona is the only state within the West Coast Regional Carbon Sequestration Partnership that has sizable salt deposits (Figure 2). In Arizona, two classes of well are defined for this type of reservoir: (1) a Class I well permit is required to solution-mine salt deposits, and (2) a Class II well permit is required for the injection of CO₂ into the caverns for EOR purposes. An Aquifer Protection Permit is also required. If CO₂ injection is not related to EOR and is to be disposed or stored into salt cavern, a Class I permit will be maintained.

Table 5 shows the potential permit requirements for salt -cavern storage of CO₂.

Table 5. Potential salt cavern permit requirements. (See Appendix I for an explanation of acronyms.)

STATE	REGULATING AGENCY	WELL/PERMIT TYPE	REGULATIONS CITED
Arizona	EPA OGCC DEQ	Class I (solution mining of salt and non EOR related) Class II (for EOR related 2 nd jurisdiction for Class II Aquifer Protection Permit	40CFR144-148 12AAC Ch7 ARS 49-241; 18AAC,Ch9



Source: National Petroleum Technology Office

Figure 2. Major salt basins in the U.S.

3.4.2 Terrestrial Options

Terrestrial CO₂ sequestration options applicable to the WESTCARB region include carbon conservation, carbon substitution, and carbon storage. Carbon conservation deals with maintaining the forestland base, reducing deforestation, reducing forest degradation by protecting forests from fires and pests, and modifying forest management through

extended rotation (as well as other techniques). Carbon substitution deals with substitution for fossil fuel-based products, energy conservation through urban forestry (*e.g.*, reducing fossil fuel consumption by using shade trees to keep buildings cool), and biomass for energy generation. Carbon storage deals with afforestation (forestation of previously unforested land), tree growth, agroforestry, and commercial forestry management (Vine, 2003). The primary terrestrial options in the WESTCARB states of Arizona, California, Oregon, and Washington are:

- Reforestation of under-producing lands (including streamside forest restoration),
- Improved forest management,
- Forest protection and conservation, and
- Fuel treatments for the reduction of the risk of uncharacteristically severe fires (potentially with associated biomass energy generation).

Both Federal and State agencies will require a permit for any land-use changes or disturbances including improved forest management, forestation, and riparian conservation. The top three options mentioned above all involve some form of land-use changes or disturbances, and hence will have the same set of permitting requirements. Terrestrial sequestration options will be discussed in two separate categories: (1) land-use changes or disturbances and (2) biomass energy generation.

3.4.2.1 Land-Use Changes or Disturbances

There are three types of land ownership pertinent to terrestrial CO₂ sequestration: Federal, State, and private. Tables below define the terrestrial CO₂ sequestration permit/contracts requirements for the WESTCARB states of Arizona (Table 6), California (Table 7), Oregon (Table 8) and Washington (Table 9). Federal land can be managed by either the U.S. Department of Agriculture, U.S. Department of Interior (UDSI) through the National Park Services, Bureau of Land Management (BLM), or Bureau of Indian Affairs. Regulations affecting private land management depend on whether the land is classified as private forest land or private ranchland.

Table 6. Potential Arizona permits/contracts for land-use changes or disturbances.
(See Appendix I for an explanation of acronyms.)

TYPE OF LAND		REGULATING AGENCY	REGULATIONS CITED
State land		State Land Dept. Dept. of Fish & Wildlife DEQ (Water Quality) U.S. Fish and Game	ARS Title 37-102 and 37-622 ARS Title 17 Ch3 AAC Title 18 Ch9 50CFR17
Federal land	USDA	USDA Dept. of Fish and Game U.S. Fish and Game	36CFR Ch1 part 1 ARS Title 17 Ch3 50CFR17
	USDI – National Parks	Not allowed	
	USDI – BLM	BLM Dept. of Fish and Game U.S. Fish and Game	43CFR part 5000-5510 ARS Title 17 Ch3 50CFR17
	USDI – Tribal land	USDI BLM Local tribunal	25CFR part1 and 163 All BLM regulations HR3826 (Tribal Forest Protection Act); local tribunal laws
Private land	Forest land	Same as State land	State land regulations
	Ranch land	County/city planning DEQ (Water Quality) Dept. of Fish and Game U.S. Fish and Game	Various county/city zoning codes AAC Title 18 Ch9 ARS Title 17 Ch3 50CFR17

Table 7. Potential California permits/contracts for land-use changes or disturbances. (See Appendix I for an explanation of acronyms.)

TYPE OF LAND		REGULATING AGENCY	REGULATIONS CITED
State land		Dept. of Forestry & Fire Protection Dept. of Fish and Game CEQA RWQCB U.S. Fish and Game	Pub Resource Code Div4 and 13; California Forest Practice Act 14CCR Div 1 Pub Resource Code Div 13 Water Code 13000 (Porter Cologne Water Quality Act) 50CFR17
Federal land	USDA	USDA Dept. of Fish and Game U.S. Fish and Game CEQA	36CFR Ch1 part 1 14CCR Div 1 50CFR17 Pub Resource Code Div 13
	USDI – National Parks	Not allowed	
	USDI – BLM	BLM Dept. of Fish and Game U.S. Fish and Game	43CFR part 5000-5510 14CCR Div 1 50CFR17
	USDI – Tribal land	USDI BLM Local tribunal	25CFR part1 and 163 All BLM regulations HR3826 (Tribal Forest Protection Act); local tribunal laws
Private land	Forest land	Same as State land	State land regulations
	Ranch land	Same as State land	State land regulations

Table 8. Potential Oregon permits/contracts for land-use changes or disturbances.
(See Appendix I for an explanation of acronyms.)

TYPE OF LAND		REGULATING AGENCY	REGULATIONS CITED
State land		ODF Dept. of Fish and Game Div. of State Lands (if impact waterways) U.S. Army Corps of Engineers (if fill wetlands or waterways) U.S. Fish and Game	OAR Ch629; ORS 527.610, State Forest Management Plan OAR Ch635 ORS 195.795-196.990 CWA Sec404 50CFR17
Federal land	USDA	USDA Dept. of Fish and Game U.S. Fish and Game	36CFR Ch1 part 1 OAR Ch635 50CFR17
	USDI – National Parks	Not allowed	
	USDI – BLM	BLM Dept. of Fish & Game U.S. Fish & Game	43CFR part 5000-5510 OAR Ch635 50CFR17
	USDI – Tribal land	USDI BLM Local tribunal	25CFR part1 and 163 All BLM regulations HR3826 (Tribal Forest Protection Act); local tribunal laws
Private land	Forest land	Same as State land	State land regulations except less stringent
	Ranch land	ODA (agriculture water quality review) Div. of State Lands (if impact waterways) U.S. Army Corps of Engineers (if fill wetlands or waterways) County planning dept.	ORS603 Div 80, 90 and 95; SB1010 ORS 195.795-196.990 CWA Sec404 Various county planning regulations

Table 9. Potential Washington permits/contracts for land-use changes or disturbances. (See Appendix I for an explanation of acronyms.)

TYPE OF LAND		REGULATING AGENCY	REGULATIONS CITED
State land		DNR Dept. of Fish and Game Dept. of Ecology (SEPA requirements) (Water Right Permit) U.S. Fish and Game	WAC Title 222 WAC Title 220 and 232 RCW43.21C WAC Title 173-152 and 173-173 50CFR17
Federal land	USDA	USDA Dept. of Fish and Game U.S. Fish and Game	36CFR Ch1 part 1 WAC Title 220 and 232 50CFR17
	USDI – National Parks	Not allowed	
	USDI – BLM	BLM Dept. of Fish and Game U.S. Fish and Game	43CFR part 5000-5510 WAC Title 220 and 232 50CFR17
	USDI – Tribal land	USDI BLM Local tribunal	25CFR part1 and 163 All BLM regulations HR3826 (Tribal Forest Protection Act); local tribunal laws
Private land	Forest land	Same as State land	State land regulations
	Ranch land	County planning dept. Dept. of Ecology (water right permit)	Various county planning regulations WAC Title 173-152 and 173-173

3.4.2.2 Biomass Energy Generation

Arizona, California, Oregon, and Washington all have the same permitting requirements for the biomass CO₂ sequestration option. Besides the State or Federal requirements discussed in the previous section, local air district, water board, and county/city planning department rules will be applicable.

Biomass is not yet economical, but can be if government will provide subsidies or tax credits. Beside local county/city planning department regulations, building of power plant for biomass energy generation will require local air district approval as well as an NPDES permit from the water board for the effluent discharge. Dead wood removal also requires a contract/permit from the land owner.

Table 10. Biomass permit contract requirements

REGULATING AGENCY	REGULATIONS CITED
State or Federal	See existing State land or Federal land regulations
Local air district	New source review (BACT); air permit
Water board	NPDES permit; water right permit
City/county planning dept.	Conditional use permit; City/county planning building permit

4 Conclusions and Recommendations

In order for CO₂ sequestration to be viable, EPA will first have to standardize injection regulations and government will possibly need to give some tax incentive or credit.

Carbon dioxide generated from industrial activities can be captured, transported and sequestered either by injecting into appropriate geologic formations, or capturing through carbon intake into the terrestrial ecosystems. EPA will probably make no distinction between storage and disposal into any medium, nor if in gaseous or liquid phase. For injection into appropriate geologic formations, options include storage in:

- Oil and gas reservoirs,
- Saline formations,
- Unmineable coal beds, and
- Salt caverns.

The permit requirements for each of the above options have been documented and their respective regulations cited. It is not yet clear how the classification of CO₂ as product or waste will influence the type of injection well or the regulating agency. EPA will most probably not differentiate between storage and disposal. Regardless of the well classification, the well will have the same standard; EPA is endeavoring to ensure a universal standard and perhaps classification to which all agencies will adhere. Ultimately, EPA, with the States' input will have to decide on the proper classification of CO₂. The classification is of lesser importance than the regulatory operational concerns such as the requirements based on criteria, standards, geology, etc., for each CO₂ injection well.

Terrestrial CO₂ sequestration involves carbon conservation, substitution and storage. The primary terrestrial options for the West Coast Regional Partnership states of Arizona, California, Oregon, and Washington are:

- Reforestation of under-producing lands (including streamside forest restoration),
- Improved forest management,
- Forest protection and conservation, and
- Fuel treatments for the reduction of risk of uncharacteristically severe fires (potentially with associated biomass energy generation).

The required permit/contract for any land use changes/disturbances and biomass energy generation have been summarized for each state. To date, biomass energy generation is not feasible without some form of government subsidy or tax credit.

Table 11 (below) shows the relative efforts in obtaining the required permits for CO₂ sequestration for the different injection and terrestrial options pertinent to the WESTCARB region. Injection of CO₂ for EOR-related projects is allowed by all states and therefore the permit is relatively easy to obtain. States with primacy will control the Class II well injection through their respective state agencies and EPA for those states without the primacy status. For the relative efforts involved in obtaining terrestrial CO₂ permits, most terrestrial options fall between two extreme cases: (1) already-in-operation (*e.g.*, EOR), to (2) not permitted (*e.g.*, harvesting in National Parks).

Table 11. Table of relative efforts

OPTIONS (from easy to difficult)	REASONS
EOR	In operation Class II wells for State with primacy, EPA without primacy
U.S. Dept. of Agriculture – Forest Service	Permit from U.S. Department of Agriculture, Forest Service U.S. Fish and Game (endangered species review) State Fish and Game (State endangered species review)
U.S. Dept. of Interior – BLM	Permit from BLM U.S. Fish and Game (endangered species review) State Fish and Game (State endangered species review)
State forestlands	Permit from State Forest and Fire Dept. State Dept. of Fish and Game U.S. Fish and Game Water right or usage permit U.S. Army Corps of Engineers (Oregon only if fills wetlands or waterways) Div. of State Lands (Oregon only if impacts waterways) CEQA (CA) SEPA (WA) review
Private forestlands Private ranchlands	Permit from State Forest and Fire Dept. State Dept. of Fish and Game U.S. Fish and Game Water right or usage permit County planning dept. (Oregon and Washington only) U.S. Army Corps of Engineers (Oregon only if fills wetlands or waterways)

	Div. of State Lands (Oregon only if impacts waterways) CEQA (CA) SEPA (WA) review
U.S. Dept. of the Interior – Indian Lands	Permit from BLM U.S. Fish and Game (Endangered species review) State Fish and Game (State endangered species review) Local tribunal laws
Subsurface Storage and Disposal	Uncertain depending on classification of CO ₂ as product or waste
Biomass	Local air permit (BACT, new source review) NPDES permit County planning dept. Permit from State forest and fire dept. State Dept. of Fish and Game U.S. Fish and Game Water right or usage permit U.S. Army Corps of Engineers (Oregon only if fills wetlands or waterways) Div. of State Lands (Oregon only if impacts waterways) CEQA (CA) SEPA (WA) review Uneconomical without tax credit or government subsidy
U.S. Dept. of Interiors – National Parks	No harvesting allowed

5 References

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Appendix

AB	Assembly Bill
ACC	Alaska Administrative Code
ACC	Arizona Administrative Code
ARS	Arizona Revised Statutes
AST	Aboveground storage tank
BACT	Best Available Control Technology
BLM	Bureau of Land Management
ECBM	Enhanced Coal-Bed Methane
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
DEP	Department of Environmental Protection
DEQ	Department of Environmental Quality
DNR	Department of Natural Resources
DOGGR	California Division of Oil, Gas and Geothermal Resources
DOM	Division of Minerals
DOT	Department of Transportation
EGR	Enhanced gas recovery
EOR	Enhanced oil recovery
EPA	Environmental Protection Agency
HR	House Rule
FERC	Federal Energy Regulatory Commission
NAC	Nevada Administrative Code
NPDES	National Pollutant Discharge and Elimination System
NRS	Nevada Revised Statutes
OAR	Oregon Administrative Rule
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
OGCC	Oil and Gas Conservation Commission
OSHA	Occupational Safety and Health Administration
PUC	Public Utility Commission
RWQCB	Regional Water Quality Control Board
SEPA	State Environmental Protection Act
USDA	U.S. Department of Agriculture
USDI	U.S. Department of Interior
UIC	Underground Injection Control
UTC	Utilities and Transportation Commission
WAC	Washington Administrative Code